# Kansas State University

## Campus Infrastructure Improvements

Retro Commissioning, Thermostats & Insulation Upgrades

## PROGRAM

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Prepared by Facilities Campus Planning and Project Management

# Introduction

Kansas State University is committed to investing in building & infrastructure improvements to positively impact the teaching, research and service objectives of our land grant mission.

Charged by University Leadership, the 'energy savings and sustainable energy sources' working group was established in November 2017 to provide recommendations for energy savings and alternative energy source ideas to have a positive impact on the Campus. Members of the working group represented a cross-section of the Campus Community, specifically with interest and/or knowledge in energy efficiency and sustainability.

Recommendations from this working group were broadly categorized into measures that affect buildings, utility systems, renewable-energy, or the Campus at large, and were analyzed for feasibility of implementation, impact to Campus and return-on-investment.

The working group recommendations outlined in this program specifically effect building infrastructure and utility systems: this program includes details for *Lab Building Retro Commissioning*, *replacement of Pneumatic Thermostats*, and *Installation of Steam & Condensate line Insulation*, totaling over $2,000,000 with approximate 7-yr simple payback.

In addition to utility savings, this energy project will positively impact comfort and functionality of building systems, while reducing maintenance demands for over 3.0-million square feet of ageing Campus infrastructure, and 13,000 linear feet of steam and condensate insulation.

## Site Map


**Additional buildings (not pictured) where utilities are paid by Admin & Finance include:**
Agronomy Operations Center, Agronomy North Farm Research center, AMI- Manufacturing Learning Center, ASI Beef Nutrition Research Center, ASI Beef Stocker Unit, ASI Dairy Office & Milk Parlor, ASI Sargent Farm Trailer House, ASI Sargent Residence, ASI Horse Research Office & Barn, ASI KABSU Business Office, ASI Poultry Foreman Residence, ASI Poultry Main Office, ASI Purebred Beef Cedar Creek Ranch Residence, ASI Purebred Beef Headquarters & Calving Center, ASI Sheep & Meat Goat Main Office, ASI Swine Main

Office, Civil Engineering Testing Lab, CMG LARC Caretakers Residence/Research Bldg./Research Trailer, Forestry Gallaher Bldg./Greenhouse/Vehicle Maintenance, Grain Science BIVAP, Hal Ross Flour Mill, International Grains Program, O.H. Kruse Feed Mill, Hazardous Waste Transfer Facility (flammables & non-flammables), KSU Transmitter Bldg., Library Annex, Mechanical Engineering Laboratory, National Gas Machinery Lab, Stanley Stout Center, Unger Complex.

# Project Descriptions

## Building Retro Commissioning – Lab Buildings

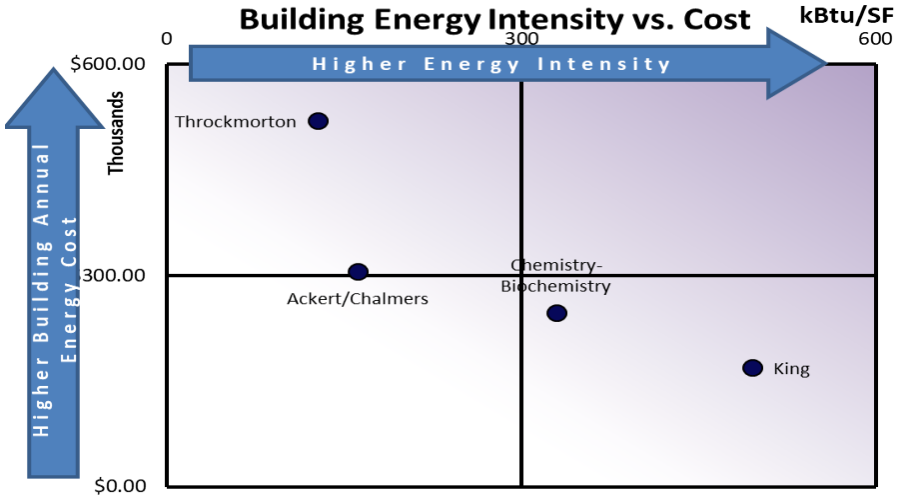
Description:

Laboratory buildings utilize 100% outside air for ventilation and are the most expensive to operate on a University Campus making them prime candidates for retro commissioning. Several factors influence the performance of a modern lab building, including: maintaining adequate air velocities with fume hoods, lab pressurization control, isolation of return air from lab spaces, high air change rates for dilution of contaminants and proper exhaust of air from Lab spaces.

Deficiencies in all of the above exist in the lab buildings at K-State, which are prime candidates to retro commission for optimal energy consumption and compliance.

Feasibility:

Lab buildings included in this scope are: Ackert/Chalmers, Bluemont, Burt, Chemistry/Bio-Chemistry, Durland/Rathbone/Fiedler/Engineering Hall, King, and Throckmorton/Greenhouse D, totaling over 1.3-million SF of Campus infrastructure. Additional buildings that contain lab equipment may be included as the project progresses and/or funding is identified.




**KSU Lab building Energy Intensity**

Impact to Campus:

Laboratory buildings consume significantly more energy that office, classrooms, and dormitory buildings of comparable size. The main driver of energy consumption in lab spaces is the high volume of ventilation air required to maintain safe working conditions. While safety is always the first priority, there is a significant opportunity for energy savings by optimizing ventilation design to the needs of each building and space. Further analysis should be performed with a certified commissioning agent with experience commissioning laboratory buildings.

ROI: 9 years
Installed Cost: $610,000
Annual Savings: $65,000 +

## Programmable Thermostats (Pneumatic controlled buildings)

Description:

Pneumatic thermostats communicate with air-handling systems through an air-filled control tube that is capable of sending signals with changes in pressure. A pneumatic thermostat utilizes a bi-metallic strip that responds to changes in room temperature with an increase or decrease of air pressure within the control tube. Pneumatic control systems were common in the 1970s and 1980s, but were replaced by direct digital controls as technology progressed. They are expensive to install and difficult to maintain; leaks in connections are common and large air compressors often run continuously as a result of poor system maintenance. Pneumatic systems lack the capability for remote readings, diagnostics, and set point control. They do not offer scheduling capabilities because they lack the ability of providing digital communication to a control platform, which means that HVAC systems in buildings with pneumatic thermostats do not correlate to when and how the building is utilized.

Feasibility:

Universities that have published case studies on their success from converting pneumatic to digital thermostats include: Toronto, California San-diego, CalTech, UC Berkley, New York (SUNY) and Western Michigan.

The following buildings have HVAC systems with pneumatic controls and present an excellent retrofit opportunity for a pneumatic-to-digital conversion so buildings can be properly scheduled with set-back temperatures during times of reduced activity.

Ackert Hall – Room t-stats and mixing box controls
Ahearn Field house- T-stats, valve controls and damper controls
Bluemont Hall- few t-stats, valve controls and damper controls
Cardwell Hall-Room t-stats, valve controls and damper controls
Dole hall- t-stats, damper controls and valve controls
Durland Hall- t-stats, damper controls, valve controls and other controls
Foundation/Unger- T-stats, valve controls, damper controls
Hale/Farrell Library-T-stats, valve controls, damper controls, and other controls
Justin Hall- T-stats, damper controls and valve controls
McCain Hall- T-stats, damper controls
Nichols Hall- T-stats, damper controls, other pneumatic controls
Peters Rec Center-T-stats, damper controls, valve controls
Rathbone Hall- T-stats, damper controls, valve controls
Shellenberger Hall- T-stats, damper controls, valve controls, other pneumatic controls
Throckmorton Hall- T-stats, damper controls, valve controls, other pneumatic controls
Weber Hall- T-stats, damper controls, valve controls and other pneumatic controls
Willard Hall- T-stats, damper controls, valve controls
Additional buildings that contain pneumatic controls may be included as the project progresses and/or funding is identified.

Impact to Campus:

A significant savings opportunity exists by scheduling buildings according to their utilization. An estimated 10% reduction in energy consumption is achievable when HVAC systems are properly scheduled and set-back temperatures are employed. Approximately 1.8-million SF of buildings on Campus still utilize pneumatic systems for HVAC control.

ROI: 4 years
Installed Cost: $945,000
Annual Savings: $234,220

### Steam & Condensate Pipe Insulation (US-2)

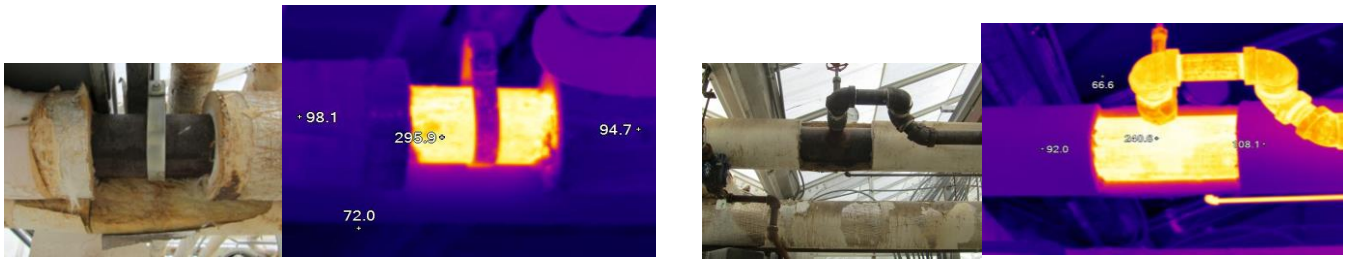
Description:

Insulating steam and condensate lines reduces heat loss from steam, and increases the water returning to the boiler. The hotter the water returning to the boiler is, the quicker it is to convert back to steam, consuming less energy to accomplish the cycle.

Heating systems may produce a "knocking" or "hammer" noise during operation (most common during heat up or cool down). This loud banging noise can be a result of many factors, one of which is lack of proper pipe insulation. If return lines lack insulation, piping will be cool; conversely, when extremely hot liquid condensate encounters cool piping, violent reactions (“hammer”) will occur and over time will cause the pipe to fail. The biggest need for insulation is located in the underground steam tunnels on Campus.

Feasibility:

This is a relatively easy improvement to implement.




**Thermal Images of exposed Steam pipe showing heat loss compared to insulated pipe**

Impact to Campus:

There is a need for over two miles of missing, deteriorated or damaged steam/condensate piping on Campus. There will be a significant positive financial impact once heating lines are properly restored with insulation.

ROI: 2.75 year
Installed Cost: $595,000
Annual Savings: $ 217,000

## Current Conditions & Space Summaries

Conditions of building components and utility systems are current with the information provided in the KBOR Fall 2018 Deferred & Annual Maintenance report, and vary widely by the age, upkeep and renewal efforts. This project impacts approximately 3.0-million GSF of Campus infrastructure and nearly 13,000 linear feet of steam and condensate piping.

## Budget

| **Estimate of Project Costs** | |
|---|---|
| **Design Fees** (Architect, Engineer, other Consultants including commissioning) | 200,000 |
| | |
| **Construction** (Construction Cost, etc.) | 1,860,000 |
| | |
| **Ancillary Contracts** (Site Survey, Geotechnical Investigation, Construction Testing) | 0 |
| | |
| **FF&E** (Furniture, A/V, equipment, etc.) | 0 |
| | |
| **Miscellaneous Costs** (Administrative fees, internal labor, ancillary contracts, etc.) | 20,000 |
| | |
| **Contingency** | 20,000 |
| **Total** | **$ 2,100,000** |

## Funding

The University intends to fund this $2,100,000 project internally with restricted fees and University interest.

## Maintenance

Because this project is an infrastructure upgrade project, no significant maintenance increases are expected; a reduction in maintenance and utility funding are expected based on energy efficient, long lasting lab solutions, pneumatic thermostats, and steam & condensate insulation.

## Timeline/Schedule

Each component within the scope of this project will be managed with internal resources, but executed by separate qualified contractors.

Obtain Engineering Services: May – June, 2019

Design: July – September 15, 2019

Bid: November, 2019

Construction: December 2019 – December 2020